# Draft

# Lewis County Critical Areas Ordinance

## *Best Available Science Review and Recommendations for Code Update*

# Critical Aquifer Recharge Areas

*Prepared for*

**Lewis County Community Development, Planning Section**
350 N Market Blvd, First Floor
Chehalis, WA 98532-2626

*Prepared by*

**Parametrix**
411 108th Avenue NE, Suite 1800
Bellevue, WA 98004-5571
425-458-6200
www.parametrix.com

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# ACRONYMS

| | |
|---|---|
| BAS | Best Available Science |
| CAO | Critical Areas Ordinance |
| CARAs | Critical Aquifer Recharge Areas |
| CTED | Office of Community Trade and Economic Development |
| Ecology | Washington Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| GIS | geographic information system |
| GMA | Growth Management Act |
| HCAs | habitat conservation areas |
| RCW | Revised Code of Washington |
| SMP | Shoreline Master Program |
| USEPA | United States Environmental Protection Agency |
| WAC | Washington Administrative Code |
| WHPAs | Wellhead Protection Areas |
| WRIA | Water Resource Inventory Area |

# 1. INTRODUCTION

In 1995, the Washington State Legislature amended the Growth Management Act (GMA) to require that local governments include Best Available Science (BAS) in designating and protecting critical areas (RCW 36.70A.172(1)). In 2000, the State's Office of Community Trade and Economic Development (CTED) adopted procedural criteria to implement these changes to the GMA and provided guidance for identifying BAS. The rule makers concluded that identifying and describing functions and values and estimating the types and likely magnitudes of adverse impacts were scientific activities. Thus, RCW 36.70A.172(1) and the implementing regulations require the substantive inclusion of BAS in developing critical area policies and regulations.

This document summarizes BAS for Lewis County critical areas and provides recommendations for updating the County's Critical Areas Ordinance (CAO).

Critical areas as defined by RCW 36.70A.050, include the following:

- Geologically hazardous areas
- Frequently flooded areas
- Critical aquifer recharge areas (CARAs)
- Wetlands (both freshwater and estuarine)
- Fish and wildlife habitat conservation areas (HCAs)

In addition, this document addresses the habitat requirements and management needs of anadromous fish, and discusses habitat mitigation banking. Maps of the County's critical areas are provided in Appendix A.

## 1.1 REPORT BACKGROUND AND PURPOSE

The information contained within this document is a summary of scientific studies related to designating and protecting critical areas, including habitat for anadromous fish species, as defined by the GMA. The information provides a basis for recommended changes and additions to the Lewis County CAO[1]. It is not intended to provide an exhaustive summary of all science available for all critical areas. The information reviewed is pertinent to Lewis County, applicable to the types of critical areas present, and is believed to be the best available scientific information. BAS means current scientific information derived from research, monitoring, inventory, survey, modeling, assessment, synthesis, and expert opinion that is:

- Logical and reasonable
- Based on quantitative analysis
- Peer reviewed
- Used in the appropriate context
- Based on accepted methods
- Well referenced.

[1] In some instances, the BAS review supports existing provisions of the County code and no changes are recommended.

In some instances the GMA and its regulations constrain the choice of science that can be used to designate or protect a particular resource (e.g., local governments are required to use the definition of wetlands [RCW 36.70A.030.2]). In other cases, there may a range of options that are supported by science (e.g., wetland buffer widths necessary to protect functions).

The State legislature and the Growth Management Hearings Boards have defined critical area "protection" to mean preservation of critical area "structure, function, and value." Local governments are not required to protect all functions and values of all critical areas, but are required to achieve "no net loss" of critical area functions and values across the jurisdictional landscape. Local governments are also required to develop regulations that reduce hazards associated with some types of critical areas including areas aquifer recharge areas. The standard of protection is to prevent adverse impacts to critical areas, to mitigate adverse impacts, and/or reduce risks associated with hazard areas.

## 1.2 RELATIONSHIP TO OTHER PLANNING EFFORTS

The recommendations derived from the BAS review will be used as the basis for revising the County's development regulations and Comprehensive Plan elements that pertain to critical areas. In addition to the provision of Lewis County Code Chapter 17.35 relating to Critical Areas and Chapter 15.35 relating to Flood Damage Prevention, this may include revisions to zoning regulations, clearing and grading provisions, stormwater management requirements, subdivisions regulations and other applicable plans and policies.

The County is also required to integrate the CAO provisions with its Shoreline Master Program (SMP), which must be updated by the end of 2012. This update of the CAO provisions is not intended to comply with Shoreline Management Act guidelines. In the future, when the Shoreline Master Program is updated, shoreline regulations pertaining to critical areas must be as protective or more protective of functions and values as the CAO regulations applicable in the rest of the county [RCW 90.58.090(4)].

## 1.3 COUNTY SETTING

Lewis County, the largest county in Washington State, encompasses 2,452 square miles in the southwest portion of the State (Figure 1). The crest of the Cascade Mountains forms the eastern boundary of the County. The County is abutted to the east by Yakima County and the Yakima Indian Reservation. It is bounded by Thurston and Pierce Counties to the north, Pacific County to the west, and Wahkiakum, Cowlitz, and Skamania Counties to the south.

The County includes the cities of Centralia, Chehalis, Winlock, Napavine, Morton, Mossyrock, Pe Ell, Toledo, and Vader. Approximately 60 percent of the County's population of 71,000 lives in unincorporated areas outside of cities. Lewis County's two largest cities, Centralia and Chehalis, are located in the western portion of the County and have a population of approximately 15,350 and 7,000, respectively.

Federal lands within Lewis County include portions of the Snoqualmie National Forest, Gifford Pinchot National Forest, Mt. St. Helens National Volcanic Monument, Mt. Rainier National Park, and Goat Rock Wilderness Area. Reservation and trust lands of the Chehalis Indian Nation are located within the County.

**Figure 1. Vicinity Map**

According to the Lewis County Comprehensive Plan, about 74 percent of land within the County is committed to federal, state, and private resource land uses. Most of this land is primarily used for mineral, agricultural, forestry, and recreational uses. Only 1 percent of the resource land lies within urban areas. Over 98 percent of Lewis County is classified as open space or remote rural areas and less than 2 percent is available for urban or more intense rural development.

Lewis County includes five watersheds (Deschutes, Upper and Lower Cowlitz, Nisqually, and Upper Chehalis) and eight State of Washington Water Resource Investigation Areas (WRIAs 11, 13, 23, 24, 25, 26, 30, and 38). The Nisqually, Chehalis, and Cowlitz Rivers are the three major rivers in the area.

The County includes the upper Chehalis Valley, much of the Cowlitz River Drainage and numerous other creeks draining the foothills and mountains. The Cowlitz River flows from the Cowlitz glacier. The valley extends west approximately 80 miles from the rugged, glacially modified mountains to the southwest part of Lewis County comprised of bottom lands, terraces, and broad plains. The Chehalis River Valley is in the southern part of the Puget Trough and includes a broad well developed flood plain and low terraces surrounded by dissected uplands of low to moderate relief with rounded ridges (Evans and Fibich 1987). The Nisqually River is fed by the Nisqually Glacier on Mount Rainier and follows part of the northern boundary of Lewis County. Small headwater portions of the Deschutes, Elochoman, Grays, and other rivers and creeks are found around the edges of Lewis County.

Tectonic and volcanic activity, glaciation, and rivers have shaped the landforms that make up Lewis County. Glacial advances from the area volcanoes and highlands eroded the underlying bedrock, creating steep mountainsides and depositing glacial sediments such as lake deposits, till, and outwash. The rivers cut through the outwash and carry coarse and fine sediments.

# 2. CRITICAL AQUIFER RECHARGE AREAS (CARAs)

CARAs are defined as areas that have a critical recharging effect on aquifers used as potable water (WAC 365-190-030). Examples include sole source aquifers designated pursuant to the federal Safe Drinking Water Act areas established for special protection pursuant to RCW 90.44, 90.48, and 90.54, and wellhead protection areas. Critical recharge areas function to protect human health from contaminated drinking water (anti-degradation of groundwater), and to maintain stream flows and moderate temperatures for fish and wildlife habitat.

## 2.1 SUMMARY OF AQUIFERS IN LEWIS COUNTY

Aquifers in Lewis County are generally located in permeable glacial deposits and stream valleys in the western part of the County, and in fractured bedrock and localized narrow stream valleys in the mountainous eastern part of the County. The aquifers in the west are most productive due to the high permeability of the glacial deposits that comprise these water-bearing units. Locations of major aquifers in Lewis County are generally coincident with the stream valleys and prairies underlain by permeable glacial deposits, as shown by the pink and yellow areas on the Lewis County Aquifer Recharge Areas map (Figure 2). Depths to groundwater in alluvial aquifers in Lewis County are less than 50 feet below ground surface (Pitz et al. 2005). Small quantities of groundwater are available from bedrock formations in Lewis County, but these formations are not considered to be significant aquifers (Garrigues et al. 1998).

## 2.2 OVERVIEW OF AQUIFER FUNCTIONS AND VALUES

### 2.2.1 Drinking Water Supply

Groundwater provides more than 65 percent of drinking water for Washington State through private wells and public water systems (Groundwater Protection Council 2004). As a water supply, groundwater has many advantages. It is naturally filtered as precipitation percolates through unsaturated soils, and is protected from turbidity, algal blooms, and other surface water quality issues. Groundwater is generally a constant cool temperature, and readily accessible with wells and pumps.

Groundwater has been used extensively for water supply in Lewis County for many years, with the largest number of wells used for domestic purposes (Weigle and Foxworthy 1962). Groundwater rights (wells authorized to pump over 5,000 gallons per day) in the Chehalis River Basin are shown on Figure 3 (Langlow Associates 1995). Cities that rely on groundwater for public water supply include Centralia, Chehalis, Napavine, Winlock, Toledo Mossyrock, and Morton. The wellhead protection areas designated by these water purveyors are described below in section 2.3.3.

### 2.2.2 Base Flow to Streams

Groundwater and surface water systems constantly interact with respect to recharge and discharge of groundwater. One critical interaction is discharge of groundwater into streams as base flow during parts of the year, and the recharge of groundwater from streams during other parts of the year. The magnitude and timing of groundwater discharge and recharge depends upon a number of factors including:

- relative elevations of the stream bed and the water table
- flow gradient between the aquifer and the stream

- water-transmitting characteristics of the geologic strata that comprise the aquifer and the stream channel
- location and extent of pumping from groundwater wells
- drainage activity
- climate
- other actions and conditions that affect aquifer recharge.

Base flow from groundwater also provides critical water volumes to support fish life cycles (including moderation of stream temperatures) and maintain water supplies that obtain water from streams and rivers.

Indications of hydraulic connection between surface water and groundwater in Lewis County are provided by Pietz et al. (2005). Results of this study show wells adjacent to the Newaukum and Chehalis Rivers respond significantly to river water level changes, and that groundwater provides the base flow to these rivers during the dry season. In certain river reaches, surface water flows into the underlying aquifers due to a transition of geologic strata from fine- to coarse-grained sand.

### 2.2.3 Discharge to and Recharge from Wetlands

Shallow aquifers can be recharged by wetlands and can also discharge to wetlands that support vegetation and wildlife. Wetlands provide beneficial water quality functions including particulate filtration and buffering of pollutants. The interrelationships of wetlands, aquifer recharge, discharge from shallow aquifers, and water quality occur on both a landscape and site-specific scale. Assessment of the potential impacts of changes in groundwater conditions (such as water-table elevation, groundwater recharge and discharge rates, and water quality) on wetlands requires field data to define wetland hydrology and function.

### 2.2.4 Storage of Infiltrated Precipitation

Aquifers can provide temporary storage of the portion of precipitation that infiltrates into the ground and moves downward past the root zone (i.e., is not lost to the system through evapotranspiration). This storage can function as a detention mechanism that reduces stormwater runoff and allows delayed discharge into streams and lakes well after the precipitation event. Stored groundwater becomes a resource for water supply, base flow, and discharge to wetlands and other surface water bodies.

## 2.3 OVERVIEW OF CRITICAL AQUIFER RECHARGE AREA ISSUES

### 2.3.1 Susceptible Aquifer Recharge Areas

Aquifer susceptibility is defined as the ease with which contaminants can move from source areas to the aquifer based solely on the characteristics of surface and subsurface geologic materials in the unsaturated zone above the aquifer (Cook 2000). For example, an aquifer with a groundwater depth less than 20 feet and overlain by course sand and gravel would have high susceptibility to contamination, but a confined aquifer overlain by 50 feet of clay would have a relatively low susceptibility.

**Figure 2-1A. Lewis County Aquifer Recharge Areas**

**Figure 2-1B. Lewis County Aquifer Recharge Areas**

**Figure 3. Groundwater Withdrawal Rights in the Upper Chehalis Basin**

Susceptibility can be estimated in a number of ways ranging from evaluation matrices supported by the scientific literature and field data, to groundwater computer models calibrated with data from field aquifer tests. Lewis County has applied soil properties (based on regional mapping of soil types by the U.S. Soil Conservation Service) to delineate aquifer recharge areas (see Figure 2).

### 2.3.2 Vulnerable Aquifer Recharge Areas

Aquifer vulnerability is defined as the combined effects of susceptibility and the presence of chemicals above the aquifer at specific locations (Cook 2000). The factors that contribute to vulnerability include the nature of the chemical threat (potential or confirmed release), the form of the chemicals (solid or liquid), the toxicity of the chemical, and the mobility of the chemicals in the subsurface.

Vulnerability can be approached from varying levels of detail. For example, non-point contamination sources such as agricultural chemicals may best be addressed on a regional scale, whereas point sources such as leaking underground storage tanks or registered hazardous waste disposal sites are best addressed on a site-specific basis. Completed and ongoing contamination studies in Lewis County have identified a number of impacts to groundwater. Releases to groundwater documented by the Department of Ecology (Ecology) (2006) are associated with a variety of contamination sources, including landfills, chemical spill sites, underground fuel storage tanks, and septic systems.

Ecology (2006) maintains a site atlas that includes hazardous materials sites from the following programs: Toxics Cleanup, Hazardous Waste & Toxics Reduction, Air Quality, Water Quality, Water Resources, Spills, Solid Waste Financial Assistance, Shoreline Environmental Assessment, Enforcement Tracking and Office of Regulatory Assistance. Figure 4 shows the distribution of these sites in Lewis County.

### 2.3.3 Wellhead Protection Areas

The 1986 amendments to the federal Safe Drinking Water Act mandated measures to protect groundwater supplies through wellhead protection. The State of Washington adopted regulations (WAC 246-290-135, Source Water Protection) to address these requirements. Potable water-supply purveyors in Washington using groundwater must develop and implement wellhead protection programs that include delineation of protection areas around each well, an inventory of contamination sources within wellhead protection areas, and development and implementation of water supply contingency and spill response plans to address contamination incidents that could cause loss of a well. The United States Environmental Protection Agency (EPA) (1987, 1993) and Washington State Department of Health (1995) provide guidance for wellhead protection program development.

The State of Washington wellhead protection regulations exclude individual domestic wells and well systems that do not meet the definition of public water supplies. Wellhead protection program guidance from the Department of Health (1995) specifies the delineation methods to be used by water purveyors based on number of customers served. These methods include aquifer mapping and computer modeling.

A number of water purveyors in Lewis County have delineated wellhead protection areas, including the cities of Centralia, Chehalis, Napavine, Winlock, Toledo Mossyrock, and Morton. Figure 5 shows the locations of wellhead protection areas in Lewis County. Sole Source Aquifers

The federal Safe Drinking Water Act also authorized the EPA to designate aquifers that are the sole or principal source of drinking water for an area. To meet the criteria for designation,

a sole source aquifer must supply at least 50 percent of the drinking water to persons living over the aquifer, and there can be no feasible alternate source of drinking water. Designated sole source aquifers are subject to EPA review for proposed projects that are to receive federal funds and that have the potential to contaminate the aquifer. No sole source aquifers are designated in Lewis County.

### 2.3.4 Susceptible Groundwater Management Areas and Special Protection Areas

WAC 173-100-010 provides guidelines, criteria, and procedures for the designation of groundwater management areas, subareas, or zones and to set forth a process for the development of groundwater management programs. The objectives of these designations are protection of groundwater quality, assurance of groundwater quantity, and efficient management of water resources for meeting future needs while recognizing existing water rights. WAC-173-200-090 addresses designation of special groundwater protection areas that require special consideration or increased protection. As of this writing, no susceptible groundwater management areas or special protection areas have been designated in Lewis County.

### 2.3.5 Groundwater Quantity

The quantity of groundwater present in aquifers under natural conditions represents an equilibrium of recharge, storage, and discharge, and responds to changes in climate. Land-use modifications that can affect groundwater quantity by reducing recharge include impervious surfaces with drainage diversion, drainage ditches, and groundwater cutoff trenches. Over pumping from wells and springs can also impact groundwater quantity. Increases in recharge also occur as a result of irrigation, leakage from irrigation canals, and septic system discharges in areas served by surface water supplies.

Historical land development and associated populations centers have occurred along river valleys where ample shallow groundwater supplies have been available from permeable sand and gravel aquifers. Wells completed in these formations are capable of sustained well yields from 200 to 3,000 gallons per minute (Garrigues et al. 1998).

## 2.4 HUMAN ACTIVITY AND AQUIFER FUNCTIONS

### 2.4.1 Groundwater Quality

Use and disposal of chemicals is the principal cause of adverse impacts to groundwater quality from human activities. Leaks and spills of chemical products and hazardous residues from manufacturing operations, storage tanks, shipping containers, and waste disposal areas are major point sources of contamination. On-site septic systems that are improperly installed or maintained are also potential point-sources of groundwater contamination. Non-point sources of groundwater contamination include runoff from agricultural areas, field application of fertilizers and manure at greater than agronomic rates, concentrated agricultural feeding operations, paved and unpaved areas used by vehicles or used for chemical storage, and areas where airborne dispersion of hazardous chemicals has contaminated soils. As noted above in Section 2.3.2, adverse impacts on groundwater quality from chemical releases and septic systems have been documented in Lewis County. Principal chemicals of concern are volatile organic chemicals, heavy metals, petroleum hydrocarbons, and nitrates.

**Figure 4A. Hazardous Materials Site**

**Figure 4B. Hazardous Materials Site**

**Figure 5. Wellhead Protected Areas Delineated in Lewis County**

Recent studies indicate that on-site septic systems can be a significant contributor to groundwater contamination, depending upon system density and hydrogeologic conditions. Generally, a maximum density of one system per one acre is sufficient to avoid groundwater contamination (Cook 2000). However, varying soil types and depths may cause modification to this suggested density.

### 2.4.2 Groundwater Quantity

Withdrawal of groundwater at rates and/or volumes exceeding natural recharge causes depletion of groundwater storage in aquifers. If this situation persists for an extended period of time, significant declines in groundwater levels and change of flow gradients and directions can occur. Damaging compaction of the aquifer matrix can result from extreme long-term water level declines. In principle, groundwater withdrawals are regulated by Ecology through water rights. However, groundwater withdrawals that are less than 5,000 gallons per day (approximately 3.5 gallons per minute continuous pumpage) and for the certain purposes (stock watering, single or group domestic purposes, industrial purposes, or watering a lawn or non-commercial garden that is not larger than one-half acre) are exempt from the water-right permitting process.

Natural groundwater recharge rates can be reduced by changes in land use. For example, agricultural drainage systems and drainage systems associated with roads and urban areas are specifically designed and constructed to intercept water that would, in an unaltered state, discharge from the site and recharge aquifers. Similarly, installation of impervious areas (such as pavement and buildings), soil compaction from heavy equipment, and changes in vegetation type and quantities can affect recharge rates to groundwater (Fair 2003). Techniques to mitigate some of these impacts are addressed by the Stormwater Manual for Western Washington (Ecology 2001)

Agricultural drainage systems, stormwater collection and conveyance systems in developed areas, and impervious surfaces all have the effect of reducing the amount of groundwater available to support base flow in streams. Decreased recharge can lower groundwater levels and cause reversal of groundwater flow directions and gradients. The aquifer is then recharged by the stream (i.e., stream flow depletions are increased), rather than discharging to the stream to augment base flow.

As of this writing, an initial search of the literature did not reveal any quantitative confirmation of groundwater depletion due to over pumpage, increases in impervious surfaces, or agricultural drainage systems. However, the Chehalis River Council (2003) identified exempt wells (wells that withdraw less than 5,000 gallons per day and are exempt from water rights permitting) as having potential impacts on instream flows, water quality, and aquatic habitat.

## 2.5 GMA REQUIREMENTS AND EXISTING REGULATIONS

### 2.5.1 GMA Requirements for Critical Aquifer Recharge Areas

#### 2.5.1.1 GMA Guidelines WAC 365-190

Growth Management Act guidelines define Critical Aquifer Recharge Areas as:

Areas with a critical recharging effect on aquifers used for potable water are areas where an aquifer that is a source of drinking water is vulnerable to contamination that would affect the potability of the water. [WAC 365-190-030(2)].

Guidelines for designation include the following:

(2) Aquifer recharge areas. Potable water is an essential life sustaining element. Much of Washington's drinking water comes from groundwater supplies. Once groundwater is contaminated it is difficult, costly, and sometimes impossible to clean up. Preventing contamination is necessary to avoid exorbitant costs, hardships, and potential physical harm to people.

The quality of groundwater in an aquifer is inextricably linked to its recharge area. Few studies have been done on aquifers and their recharge areas in Washington State. In the cases in which aquifers and their recharge areas have been studied, affected counties and cities should use this information as the base for classifying and designating these areas.

Where no specific studies have been done, counties and cities may use existing soil and surficial geologic information to determine where recharge areas are. To determine the threat to groundwater quality, existing land use activities and their potential to lead to contamination should be evaluated.

Counties and cities shall classify recharge areas for aquifers according to the vulnerability of the aquifer. Vulnerability is the combined effect of hydrogeological susceptibility to contamination and the contamination loading potential. High vulnerability is indicated by land uses that contribute contamination that may degrade groundwater, and hydrogeologic conditions that facilitate degradation. Low vulnerability is indicated by land uses that do not contribute contaminants that will degrade groundwater, and by hydrogeologic conditions that do not facilitate degradation.

(a) To characterize hydrogeologic susceptibility of the recharge area to contamination, counties and cities may consider the following physical characteristics:

(i) Depth to groundwater;

(ii) Aquifer properties such as hydraulic conductivity and gradients;

(iii) Soil (texture, permeability, and contaminant attenuation properties);

(iv) Characteristics of the vadose zone including permeability and attenuation properties; and

(v) Other relevant factors.

(b) The following may be considered to evaluate the contaminant loading potential:

(i) General land use;

(ii) Waste disposal sites;

(iii) Agriculture activities;

(iv) Well logs and water quality test results; and

(v) Other information about the potential for contamination.

(c) Classification strategy for recharge areas should be to maintain the quality of the groundwater, with particular attention to recharge areas of high susceptibility. In recharge areas that are highly vulnerable, studies should be initiated to determine if groundwater contamination has occurred. Classification of these areas should include consideration of the degree to which the aquifer is used as a potable water source, feasibility of protective measures to preclude further degradation, availability of treatment measures to maintain potability, and availability of alternative potable water sources.

(d) Examples of areas with a critical recharging effect on aquifers used for potable water may include:

(i) Sole source aquifer recharge areas designated pursuant to the Federal Safe Drinking Water Act.

(ii) Areas established for special protection pursuant to a groundwater management program, chapters 90.44, 90.48, and 90.54 RCW, and chapters 173-100 and 173-200 WAC.

(iii) Areas designated for wellhead protection pursuant to the Federal Safe Drinking Water Act.

(iv) Other areas meeting the definition of "areas with a critical recharging effect on aquifers used for potable water" in these guidelines. [WAC 365-190-080(2)].

#### 2.5.1.2 Growth Management Hearings Board Decisions

Specific Growth Management Hearings Board Decisions on CARAs include the following:

"Where certain aquifer recharge areas were not "critical" because they were not vulnerable to contamination, their lack of designation was within Best Available Science as shown by the record." *WWGMHB ARD 98-2-0005*

"If the county… wishes to adopt less-than precautionary protection standards and Best Management Practices, an adaptive management program must be developed and implemented that would ensure that monitoring of new and existing wells would continue and more strict protective action were planned for and ready to implement at once if the adopted strategies are not adequate." *WWGMHB Olympic Environmental Council 01-2-0015*

"The County's approach, to rely on identification of [aquifer recharge areas] on a site-by-site basis, is within the range of choices available to local governments to satisfy the designate and protect mandates for critical areas." *CPSGMHB Sakura, 02321, 2/12/03*

"The Board found that in updating the CAO the County considered the CTED guidelines in protecting critical aquifer recharge areas. The classification based on vulnerability to contamination was based upon best available science. The County is not restricted to reliance upon sole source aquifers and wellhead protection zones." *CPSGMHB Keesing CAO, 053*

### 2.5.2 Lewis County CARA Regulations

#### 2.5.2.1 Aquifer Susceptibility and Vulnerability to Contamination

Three factors generally dominate determination of aquifer susceptibility (Cook 2000):

- overall permeability of the unsaturated zone (soil and underlying geologic strata);
- thickness of the unsaturated zone (depth to groundwater in unconfined aquifers); and

- amount of available recharge.

Rating systems with tables of representative values of geologic characteristics are available from guidance documents (Cook 2000) and technical references. These rating systems can be applied to specific aquifers to obtain a relative susceptibility score, which can then be used to support development of policies and protective measures.

Aquifer vulnerability is generally more difficult to address because of the significant amount of time required to obtain and organize information regarding the distribution of chemicals in areas underlain by aquifers. Organizations with effective geographic information system (GIS) resources and staff availability (such as Lewis County) are best equipped to add a vulnerability component to CARA designation. Existing resources such as the pilot study of aquifer vulnerability in the Nooksack Basin (Morgan 1999), the contaminated sites mapped by Ecology, and the documented areas of nitrate and pesticide contamination are available to support this effort.

Data already compiled and described above are sufficient to support determination of aquifer susceptibility and vulnerability in Lewis County. General recommendations regarding rating systems are provided below.

#### 2.5.2.2 Wellhead Protection Areas

Wellhead protection areas (WHPAs) designated by water purveyors (as required by WAC 246-290-145) and mapped by Ecology (2006) should be added to the County's aquifer recharge area map, showing the 10-year ground-water travel-time area to each well or well field. Superposition of all designated WHPAs illustrates where aquifers are currently used for water supply. The mapping should be updated periodically to allow for additions and deletions of specific water wells. These data should be checked with State of Washington Department of Health and Lewis County records.

#### 2.5.2.3 Areas of Groundwater Overdrafts and Water-Level Declines

The quantity aspect of CARAs is best addressed by identifying and mapping aquifer areas where withdrawals have caused depletion of storage and resulting declines in water levels (i.e., "groundwater mining"). Other contributing factors to groundwater level declines include agricultural drainage systems installed to lower groundwater levels, stormwater collection and conveyance systems along roads, and impedance of groundwater recharge by impervious surfaces. These phenomena may be evident on a local or regional basis. If such impacts are documented in the future, this information should be added to the County's aquifer recharge area map under the "Severe" category, and the CARA regulations should be modified to include groundwater declines as an aquifer recharge issue.

### 2.5.3 Inventory of Known or Potential Groundwater Contamination Sources

The Ecology site atlas noted in Section 2.3.2 should be used to identify such sites that pose risk to aquifer recharges areas. By superimposing this data on the existing aquifer recharge map, the aggregate risk to aquifer recharge area from susceptibility (physical properties) and vulnerability (contamination) may be assessed.

### 2.5.4 Prohibited, Conditionally Permitted, and Exempt Activities

The listing of prohibited activities provided in Section 17.35.880 of the existing Lewis County code provides a very detailed and complete listing for protection of aquifer recharge areas. Minor adjustments would be helpful to clarify the relationship between protections

provided by existing State and County codes versus additional protections specified for aquifer recharge areas.

### 2.5.5 Site-Specific Hydrogeologic Reports

One of the most effective and documentable means of evaluating potential adverse impacts to CARAs and supporting conditional use permit applications is a site-specific evaluation of hydrogeologic conditions and project impacts to groundwater. Cook (2000) provides a comprehensive listing of potential requirements for such investigations and reports. A site-specific investigation provides the opportunity to tie together potential impacts of the project to groundwater quality, recharge, discharges to streams and wetlands, and water levels. Requirements for hydrogeologic reports can be adjusted according to aquifer susceptibility.

The existing requirements for technical reports in Section 17.35.880 of the Lewis County code appear to be overlapping with State regulations. Avoiding duplication of effort for the regulated public should be considered. For example, the documentation requirements for solid waste landfills are already covered in details by State regulations (WAC 173-304, WAC 173-350, and WAC 173-351).

## 2.6 GAP ANALYSIS AND REGULATORY OPTIONS

| Finding | Recommendation |
|---|---|
| **General CARA Findings and Recommendations** | |
| Finding #1 | Existing data and reports, combined with the GIS capabilities of the County, provide a sufficient information base to support development of CARA designations and aquifer protection measures by Lewis County. |
| Minimum Requirements | Use water quality, water quantity, and land use data to support creation of the CARA component of Article 5 of the County Code. |
| Options for Additional Regulation or Improvements | The County could sponsor development of a more detailed system of identifying aquifer recharge areas, such as using matrices proposed by Cook (2000) that include more detailed hydrogeologic information. These studies tend to be very expensive. |
| **Characterization and Mapping of Aquifers in Lewis County** | |
| Finding #2 | Existing data are sufficient to support mapping of major aquifers in Lewis County. |
| Minimum Requirements | Add groundwater rights information for all of Lewis County (from State data sources) as a layer on the existing County aquifer recharge area map, to confirm that these areas of pumpage are included in the moderate to severe recharge categories. |
| Options for Additional Regulation or Improvements | A more detailed mapping of aquifers and aquifer type (unconfined versus confined) is not currently available, although some localized studies provide a small amount of data. As discussed above, these types of studies are expensive. |
| **Determination of Aquifer Susceptibility and Vulnerability to Contamination** | |
| Finding #3 | Existing data are sufficient to determine aquifer susceptibility and to support vulnerability assessment. |
| Minimum Requirements | Use the guidance and data resources in Appendix Two of Cook (2000) as the basis for determining susceptibility of the areas on the existing aquifer recharge area map. Support with recent field data if available. Plot on the existing aquifer recharge area map to create a combined susceptibility and vulnerability map, and apply updated color codes to map the combined attributes of susceptibility and vulnerability of these aquifers. |

## GAP ANALYSIS AND REGULATORY OPTIONS (CONTINUED)

| Finding | Recommendation |
|---|---|
| **Determination of Aquifer Susceptibility and Vulnerability to Contamination (continued)** | |
| Finding #3<br>Minimum Requirements (con't) | Confirm the locations of designated wellhead protection areas (WHPA) from public supply wells, using information from water purveyors, Lewis County Public Health, and the State Department of Health as resources. Superimpose WHPAs on the CARA map. |
| | Evaluate the results of the contamination inventory (see below), to determine if or when to add a vulnerability analysis to the susceptibility determination. Consider the incremental resources and costs required to accomplish this step. |
| | If groundwater level declines become a documented problem in the future, identify areas of groundwater level declines and potential overdraft, in coordination with Ecology. Plot on the aquifer recharge area map. |
| Options for Additional Regulation or Improvements | None at this time. |
| **Inventory of Known or Potential Groundwater Contamination Sources** | |
| Finding #4 | Resources are available to map point and some non-point contamination sources, including Ecology web site mapping tools and technical reports of past contamination incidents. |
| Minimum Requirements | Transfer locations of hazardous materials facilities from Ecology (2006) to the aquifer recharge area map, to support assessment of aquifer vulnerability. Update this mapping every 5 years. |
| Options for Additional Regulation or Improvements | None at this time. |
| **Develop Sections for Update of Chapter 17.35, Critical Areas, Article IV(E), Aquifer Recharge Areas (as needed)** | |
| Finding #6 | The existing Lewis County Code generally addresses the required CARA elements described in the Model Code. A few adjustments are recommended. |
| Minimum Requirements | Complete the vulnerability mapping described in Section 2.5.2.1.<br>Update the code definitions and prohibited uses to reflect the combined ratings of susceptibility and vulnerability. |
| Options for Additional Regulation or Improvements | Check the prohibited uses and technical reporting requirements for consistency with existing Federal, State, and County regulations. |

# 3. CARA REFERENCES

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